Brookhaven National Laboratory

SNS

Ring and Transfer Lines Systems

O C T O B E R

MONTHLY REPORT

01 October – 31 October 2002

Performing Organization:	Brookhaven Science Associates
Location:	Brookhaven National Laboratory Upton, New York 11973-5000
Contract Period:	October 1998 – June 2006

Brookhaven National Laboratory
SNS MONTHLY PROGRESS REPORT
October 2002
Ring and Transfer Lines Systems

I. Senior Team Leader Assessment

1. TECHNICAL PROGRESS AND ACCOMPLISHMENTS

- The BA (budget authorization) for FY2003 is $26M for BNL on SNS Ring and Transport systems, plus $2.1M for the ring/transport controls system.
- Diagnostics group has been supporting ORNL on Front End commissioning. The effort is post-handoff for the wire scanners, current monitors, and laser monitor systems built at BNL.
- In support of the Front End commissioning starting Oct 2002, C-AD prepared six "chip-monk" radiation monitors shipped to ORNL.
- The first phase of tests was performed at AGS linac on diamond stripping foil developed at ORNL/UT. The lifetime of the foil is satisfactory. Second-phase test will be on the foil support.
- In preparation of the first Ring half-cell delivery to ORNL, two-stage acceptance was executed, first on half-cell individual component and then on the assembly (Tepikian, Hemmer, group leaders). The half-cell is scheduled for shipping on Nov. 5, 2002, more than two months ahead of schedule.
- The purchasing orders for the ring power-supply systems are complete with the order for the ring extraction pulse-forming network (PFN) made this month.
- The milestone for the design completion of ring/transport system is July 2003, marked by the final design reviews of various systems.
- The accelerator physics group continues to evaluate the impact, and to optimize the field quality of the Lambertson extraction septum magnet and the 30cm narrow quadrupole magnets (Tsoupas, Fedotov, et al).

2. ISSUES AND ACTIONS

- ASAC Recommendations, supported by the recent DOE Review, needs to be authorized, funded and implemented. Awaiting Project direction.

3. COST AND SCHEDULE STATUS

3.1 VARIANCE ANALYSIS AND PROJECT COST PERFORMANCE REPORTS

WBS 1.1.3 R&D

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
5115.0	5115.0	5112.9	0.00	0.0%	2.1	0.0%

Variance Statement: Cum variances are within thresholds. No analysis required.
No current period activity.

Project Impact: None.

Corrective Action: None.

WBS 1.5 Ring and Transfer Lines

BCWS	BCWP	ACWP	SV	%	CV	%
61781.5	60950.5	59895.7	(830.98)	-1.3%	1054.9	1.7%

Variance Statement: Variances are within thresholds. No analysis required.
Current period SV is driven by WBS 1.5.1, 1.5.2, 1.5.3, & 1.5.7
Additionally, PCR R102023 was incorporated in this current period.

Project Impact: None.

Corrective Action: None

3.2 MILESTONE STATUS

WBS 1.5 and 1.1.3 have no level 0 milestones. Milestone status is listed below.

Milestones	Level 1	Level 2	Level 3	Level 4	Level 5
Project	0	1	3	13	127
FY03	0	0	0	0	20
Due in Next 30 days	0	0	0	0	0
Total Due at present	0	0	3	12	108
Made	0	0	3	12	97
Missed	0	0	0	1	12
Ahead of Schedule	0	0	0	0	1

3.3 PROJECT CRITICAL PATH ANALYSIS

The critical path items for the Ring is ring diagnostics.

II. Detail R&D Subproject Status

WBS 1.1.3 – Ring System Development

All work covered by R&D funds is essentially complete.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
5115.0	5115.0	5112.9	0.00	0.0%	2.1	0.0%

Variance Statement: Cum variances are within thresholds. No analysis required.
No current period activity.

Project Impact: None.

Corrective Action: None.

III. Detail Line Item Subproject Status

WBS 1.5.1 – HEBT Systems

Phone conferences continued with Tesla during the month on the HEBT dipole magnet. They are machining the final HEBT dipole magnet. They have started work on the HEBT/RTBT 21Q40 magnets. Phone conferences continued with Danfysik during the month. They are nearly complete with their order. ORNL has begun repairs of the magnets at SNS. Both vendors were visited during the month.

The design of the 12cm quadrupole chamber welding fixture continues. Assembly and welding of all eight 21cm quadrupole chambers has been completed. The cutting list for the 12cm beam pipes has been generated for Central Shop.

Drawings of the HEBT momentum dump are complete, and are being reviewed. Drawings of the collimators are at the vendor (SDMS), and manufacturing of the HEBT collimators is to start. Outer shield arrangements have also been designed, and are being reviewed.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
5715.9	6241.5	4806.0	525.56	9.2%	1435.4	23.0%

Variance Statement: Cum CV of $1435.4K (23%) is material driven by 1.5.1.1.1 HEBT 8D533 Magnet, Whereas 8 of 9 magnets were received (608K). ACWP is understated and will be accrued in a subsequent current period. Current period CV $233.3K (68.7%) is driven material deliveries for WBS 1.5.1.1.1 HEBT Magnet Dipole & WBS 1.5.1.1.3 HEBT Magnet Corrector. Current period SV $189.8 (126.6%) is also driven by WBS 1.5.1.1.1 & WBS 1.5.1.1.3.

Project Impact: None.

Corrective Action: None.

WBS 1.5.2 – Injection Systems

The long pulsed dipole full power test is continuing. The wedge clamps for damping the coil vibration have been fabricated. The test vacuum chamber has been TiN coated. The first two ceramic chambers are in the vacuum lab for bake out and Titanium-Nitride coating. They will not be available until November. In the meantime the vacuum group will provide a coated test chamber for magnet measurements. Ceramic Magnetics, Inc. has started fabrication of the production ferrite. The BNL shops have started to buy material for the fabrication of components for both the long and short kickers.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
4772.1	5125.6	4917.6	353.57	7.4%	208.0	4.1%

Variance Statement: Variances are within thresholds. No analysis required.
Current period CV -$296.6K (-184.7%) is driven by material deliveries for WBS 1.5.2.2 Injection Kicker Power Supply whereas BCWS and BCWP are understated and do not reflect actual cost of material received. Current period SV $104.6K (186.9%) is driven by material deliveries for WBS 1.5.2.3 DC Magnets, whereas BCWP was taken in advance of BCWS and ACWP; ACWP will be accrued in a subsequent current period.

Project Impact: None.

Corrective Action: None.

WBS 1.5.3 – Magnet Systems

The first half-cell has been assembled and is undergoing final checks before its November 5, 2002 shipping date. The magnet sign off parameters have been designed and the approval sheet is being signed off. The magnets for the next half-cell have been identified.

The SNS magnet parameter sheets for each magnet type are being reviewed separately by the cognizant physicists, engineers, and managers. The first sheets have been fully approved and scanned into the documentation system

At this time all of the 17D120 ring dipole magnets (ITF that is $<1 \times 10^{-4}$ from the nominal value) have magnetically measured and been fully shimmed. Measurements of 27 dipoles with their final shim configuration have been completed and approved for installation.

There are now 23 - 21Q40's now at BNL. Tesla was visited during the month and the last batch of magnets will be shipped in December. Production measurements of the nine 21Q40 have been completed. The integral field requirement for the magnets has been stiffened so now there are two magnets have integral fields that are close enough for them to be matched in the same power supply string. A great amount of effort has been necessary to bring the 1 kA power supply, used for the quads, into proper operation. Quadrupole measurements made thus far have more noise than expected on the basis of similar, previous measurements. Investigation has failed to reveal an isolated cause. Two changes were made to compensate: measurements of the excitation function were fit to a high-order polynomial and the current was read out three times every time the measuring coil voltage was read. This significantly reduced the noise effects. At the end of this work, the power supply failed altogether. It has since been repaired. The repair

will be tested in November by re-measuring a quadrupole that has already been measured. (Noise from operation of the AGS Booster may still be a problem.)

All of the water fittings on the first delivered 21Q40 were replaced. Fittings are being made for the rest of the magnets in house. Tesla is modifying their modification method for the rest of the magnets. They have sent a sample fitting to demonstrate their ability to properly braze a stainless steel fitting.

The second set of pole tips for the 26Q40 has been modified and the magnet has been reassembled. The harmonic coil is being surveyed onto the magnet's mechanical centerline in preparation for the third set of measurements.

The first article 30Q58 with a modified pole depth was reassembled and magnetic measurements completed. The results of the measurements indicated that a slight additional change to the pole depth is required to bring the duodecapole into specification. An ECN has been issued.

Eight of the nine 21CS26 sextupole correctors were measured. The integral transfer functions (ITF) have Std. Dev. ~ 0.1%. However, the ITF of one of them is ~ 0.7% lower than the rest. This result is being rechecked. A schedule of production measurements for the 21cm multipole magnets has been defined and re-defined. At this time the next set of magnets to be measured is the 27CDM30 (four magnets) and then back to finding 21Q40 families.

Wiring of the measuring coil for the 26cm quadrupoles and related magnets is complete. Mounting of the ends of the coil cylinder has begun.

The drawings for the 26S26 high field sextupole have been checked and the procurement package is prepared. It will go out to bid next week.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
11126.4	10979.5	11287.5	(146.87)	-1.3%	(308.0)	-2.8%

Variance Statement: Cum variances are within thresholds. No analysis required.
Current period SV $94.5K (62.7%) is driven by WBS 1.5.3.1 High Field Magnets and WBS 1.5.3.4 magnet measurement, whereas BCWP was taken in advance of BCWS and ACWP; ACWP will be accrued in a subsequent current period.

Project Impact: None.

Corrective Action: None.

WBS 1.5.4 – Power Supply Systems

The contract for the production of the extraction kickers has been awarded. This means that all power supplies, including low field correctors, medium range, main dipole, injection kicker and extraction kicker power supplies, have been placed.

Design reviews, vendor support, and first article testing is still ongoing. Design reviews are scheduled in November for the production of the injection power supplies, and in December for the main dipole power supply and production of the medium range power supplies.

First article testing of the 5040A, 18V medium range power supply will be held in December. First article testing of the RF Tuning power supply will take place in either December or January.

Low field corrector shipments are now occurring at a regular rate.

Polarity conventions for connecting power supplies to magnets have been established. A listing for individual magnets is being generated.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
1227.8	966.7	1114.8	(261.11)	-21.3%	(148.1)	-15.3%

Variance Statement: Cum SV of -$261.1K (-21.3%) & CV -$148.1 (-15.3% are driven by Ring Quad PS & Ring Low Field PS deliveries and labor issues. Current Period variances are within thresholds.

Project Impact: None.

Corrective Action: None.

WBS 1.5.5 – Ring Vacuum System

The ion pump was test-mounted on the first type A halfcell chamber/magnets. The Central Shop made all the ion pump support plates. The 30cm doublet chamber assemblies for injection and rf straight sections have been delivered by the vendor. The design of the doublet chamber welding fixture has been started. The 2nd and 3rd sets of RF cavity pipes have been coated with TiN and delivered to RF Group for assembly and testing. Outgassing rate of a halfcell chamber w/o 450C vacuum degassing was measured and found to be ~ ten times higher than the one with 450C vacuum degassing.

Delivery of TMP Carts from Varian continues. An order for HEBT, Ring, and RTBT PLC modules and wiring components was placed and partially received. The work planning on vacuum control and software for the next six months was discussed and agreed upon. Progress has been made on serial device support, ControlNet communication between PLCs and EPICS RDB tools. The PLC current time display on EDM screen through IOC has been implemented to monitor the health of the PLCs.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
5165.3	5070.1	5169.8	(95.19)	-1.8%	(99.7)	-2.0%

Variance Statement: Variances are within thresholds. No analysis required.
Current period CV -$61.7K (-57.9%) is material driven by 1.5.5.1 Ring Vacuum Chambers and 1.5.5.2 Ring Vacuum pumps; whereas BCWP for material is understated and will be credited in a subsequent current period.

Project Impact: None.

Corrective Action: None.

WBS 1.5.6 – RF System

- The first article cavity was fully tested. This cavity was driven open loop using the low level system, which included the DSP and IQ modulator. The system was pulsed at 60 HZ with realistic voltage profiles.

- The parasitic coupling impedance of the RF cavity was measured. It is small and will not have a significant impact on operations.

- Studies of electron cloud effects continued.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
7417.3	7070.0	7128.8	(347.32)	-4.7%	(58.8)	0.8%

Variance Statement: Cum variances are within thresholds. No analysis required.
Current period SV -$72.9K (-45%) is labor driven by WBS 1.5.6.1.3 RF Power amplifier assy.; whereas no performance (BCWP) was recorded against current period BCWS. Current period CV $119.5K (134.3%) is material driven by WBS 1.5.6.1 High Level RF & 1.5.6.2 Low Level RF.

Project Impact: None.

Corrective Action: None.

WBS 1.5.7 – Ring Diagnostics

Three group members attended the ORNL ICFA Diagnostics Workshop in October. Presentations were given on measurement of incoherent tune, halo measurement, transverse profile measurement in the SNS Ring, and low power laser wire measurements. During that time at ORNL group members also participated in preparations for MEBT re-commissioning. Considerable effort was devoted to preparations for the upcoming DOE Review.

Nine additional 21cm and five 26cm BPM PUEs were delivered to the Vacuum Group for final welding into the beampipes. Design continues on the BPM IFE and the baseband/RF multiplexer.

A PCR was submitted for electromagnets for the IPM. Detailed design of the IPM magnet has been halted pending approval of the PCR. Detailed design of the detector and vacuum chamber has begun. Controls group has assigned an engineer to the control system for the IPM gas system. Work continues on the luminescence profile monitor. Assembly of five Argonne-style electron detectors for testing in the RHIC ring (and comparison with CERN style detectors) was completed.

Vendor fabrication and evaluation of the improved BLM ion chamber prototypes continues. Work continues on signal processing and integration techniques for the neutron detectors. AFE, MPS comparator, and chassis back plane PCB design is underway. Evaluation of various BLM cable capacitance balancing solutions is underway. Detailed cable information and connector ordering information has been given to ORNL for the February DTL run. Testing of the ISEG VME HV bias supply switching noise influence on adjacent digitizer boards was completed. Discussions continue on finding the additional rack space needed to implement the hardware required for system redundancy throughout the SNS facility.

Mechanical assembly of the prototype BCM was completed. Responded to a request from ORNL to provide software for difference current measurements. Completed construction of calibration hardware, and added calibration software to automate the calibration process. Simulated testing with calibrator at ORNL to help identify problem with one transformer.

The six MEBT Carbon Wire Scanners were received at ORNL. A group member travelled to ORNL to assist with handoff of the MEBT Carbon Wire Scanners. Discussions of aperture requirements for the HEBT wire scanners (fabricated by LANL) continue.

A PCR was written for the third camera in the Video Foil Monitor system (as recommended by the ASAC Review Committee), to monitor the electron catcher.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
7236.6	6887.2	6854.1	(349.42)	-4.8%	33.0	0.5%

Variance Statement: Cum variances are within thresholds. No analysis required.
Current period SV $186K (130.2%) is labor driven by WBS 1.5.7.3. Beam Loss Monitor Assy. & Support. Current period CV $151.3K (46%) is also labor driven by the same WBS 1.5.7.3. An activity was completed and BCWP adjusted without any current period accrual of ACWP, hence the positive CV.

Project Impact: None.

Corrective Action: None.

WBS 1.5.8 – Collimation and Shielding

Work is continuing on the first scraper for the Ring. The ring secondary and tertiary absorber drawings are being reviewed. Specifications for the flange at the ends of the vacuum chamber are still being finalized. Finally, the vacuum chambers before and after the primary collimator are being integrated with the collimator. The collimator lifting fixture is being integrated into the secondary shielding.

Drawings of the modified shield are complete. A review with project office staff was carried out, and the drawings are now in checking.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
1817.9	1635.5	1649.6	(182.4)	-10.0%	(14.1)	-0.9%

Variance Statement: Cum schedule variance (SV) of -$182.4K (-10.0%) is material driven by 1.5.8.1 Ring Collimator 1st delivery; whereas delivery will be in March ’03 thus reducing the SV.
Cum variances are within thresholds. No analysis required.

Project Impact: None.

Corrective Action: None.

WBS 1.5.9 – Extraction System

APS of Long Island NY is the lowest bidder for the PFN and has been awarded the contract. Four sets of hard drawing copies and 1 CD with all DESKTOP drawing files have been sent to APS to start the production. Detail design of the down stream extraction kicker is complete. The upstream kicker assembly design is moving along. The 4 types of kicker magnet modules are done. Detail work is on the chamber and support.

There was a design review for the extraction straight section layout, the extraction kicker magnet design, and the extraction lambertson magnet design on 10/10/02. There were no major issues. The detailed design of the extraction lambertson magnet is proceeding but there is an issue with the stray field at the downstream end affecting the circulating beam. There may be a parameter change to deal with this issue.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
1742.8	1671.1	1754.6	(71.64)	-4.1%	(83.4)	-5.0%

Variance Statement: Variances are within thresholds. No analysis required.

Project Impact: None

Corrective Action: None.

WBS 1.5.10 – RTBT System

Ranor has completed machining the first cores for the large aperture radiation resistant quadrupoles. They are aligning and pinning the magnet. It will be shipped next month after inspection and painting. A presentation was made to M. Hechler, G. Murdoch, and T. Hunter on the design and geometry for the upstream end of the RTBT line as part of the lambertson review. The magnet stand assembly drawings for the RTBT/HEBT 21Q40/27CD30 magnets are still in checking (they were bumped for another job).

The RTBT Vacuum System design was presented to SNS visitors this month. Important installation and maintenance issues were addressed. The Extraction Region was also presented to SNS visitors. The complex extraction geometry, including the split Lambertson Septum Magnet chamber was reviewed. Open issues from the meeting are being addressed; e.g., large quick-disconnect flanges, short bellows assemblies, etc.

A modified top plate of the inner shield box has been designed and is being qualified. The technique developed for this collimator will be used on the ring collimators as well.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
3109.3	2853.1	3083.1	(256.16)	-8.2%	(229.9)	-8.1%

Variance Statement: Cum variances are within thresholds. No analysis required.
Current period CV of $26.5K (39%) is driven by an increase to % complete in RTBT Magnet Assy & Support; and RTBT Collimator & Shielding Support Magnet Assy, each from 0% to 17% complete.

Project Impact: None.

Corrective Action: None.

WBS 1.5.12 – Technical Support

- Group member participated in ICFA workshop on diagnostics for high intensity
- RF cavity longitudinal impedance were re-measured with sorted ceramic ring and found no higher order modes
- Talman and Malitsky finished scheme for beam based BPM alignment (tech note)
- Estimate for beam scrubbing to reduce e-p effect were carried out
- Work continues to optimize the stray field in Lambertson seen by circulating beam
- Group has accepted first half cell
- Sorting for dipole and 21Q40 continues

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
12449.5	12449.5	12129.1	0.00	0.0%	320.4	2.6%

Variance Statement: Variances are within thresholds. No analysis required.

Project Impact: None.

Corrective Action: None.

WBS 1.9.5.2 - Power Supply Controls

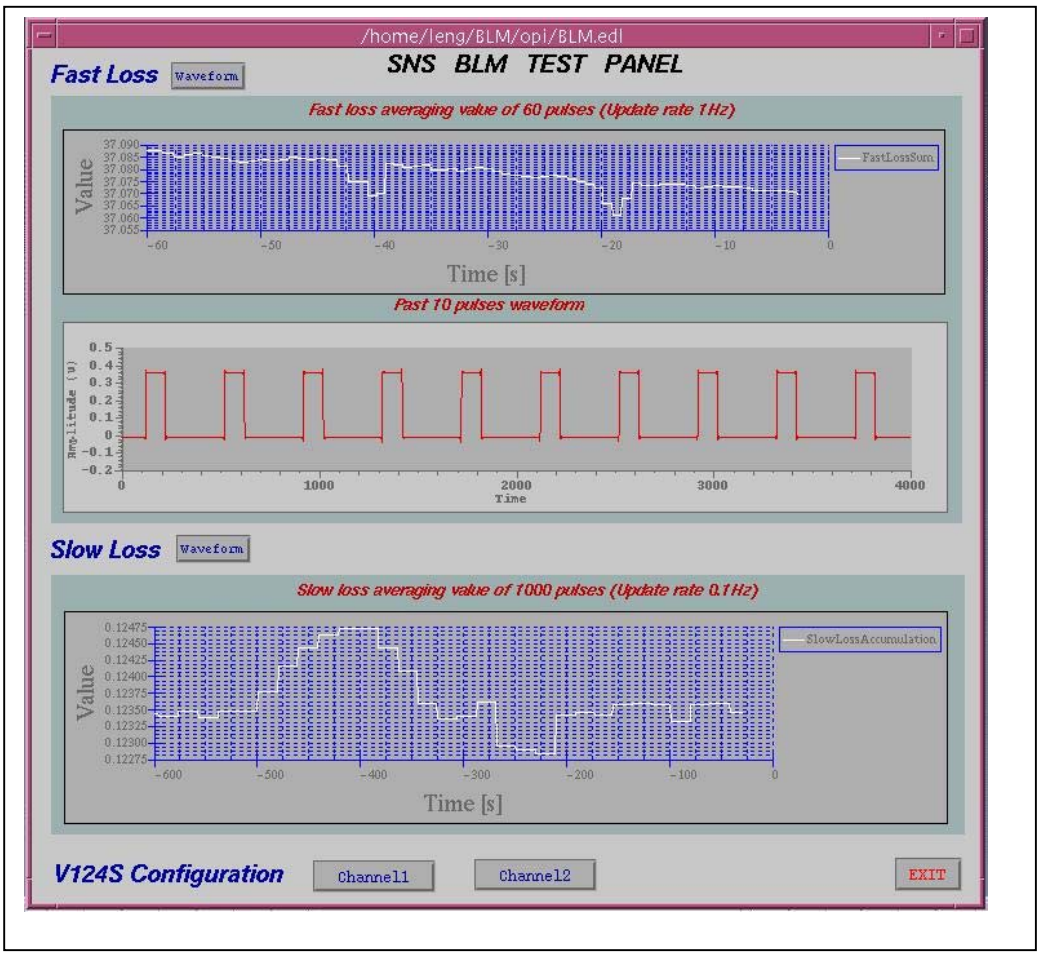
A very low level of transmission errors had been observed with some PSCs. The error showed up as a timeout, which occurred only once per several million transmissions, then instantly cleared. The problem had only been observed on a handful of PSC modules, all still at BNL.

Independently, one of the PSI units in use at BNL's AGS developed an intermittent communication error. In the case of the PSI, the root cause of the problem was improper soldering of the fiber optic transceiver to the ground plane of the PC board. A study is now underway to try to identify any malfunctioning PSCs and carefully inspect the soldering of the fiber optic transceiver. Three weeks into the study no malfunctioning PSCs have been identified.

WBS 1.9.5.3 – Diagnostics

Work continues on the BLM IOC application. There is currently a performance bottleneck which limits update rate to 30Hz, rather than the necessary 60Hz. The first EDM display screens are in use, displaying data from a simulated source. The digitizers are being triggered via V124S (timing decoder) modules. Additional screens are needed for configuration parameters, such as gain, HV bias level, and MPS trip levels. All of the VMEbus boards needed for DTL commissioning have been ordered.

Beam Loss Monitor demo system test main panel



There are three monitors (two Stripcharts and one X-Y plot) and four related display control buttons on this test panel.

Fast Loss

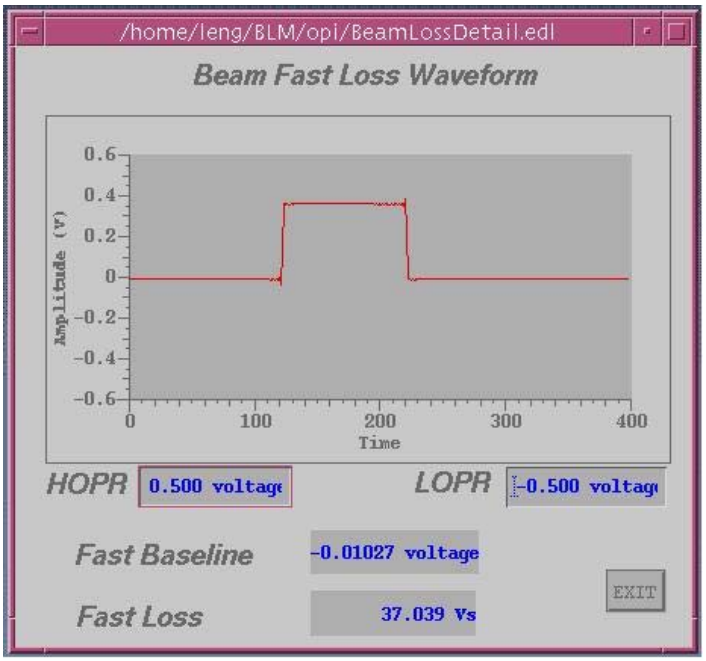
Stripchart	Display the average fast beam loss value of past 60 pulses (1s)
X-Y plot	Display the fast beam loss waveform of past 10 pulses
Waveform	Call sub panel to display current fast beam loss waveform

Slow Loss

Stripchart	Display the average slow beam loss value of past 1000 pulses (16.7s)
Waveform	Call sub panel to display current slow beam loss waveform

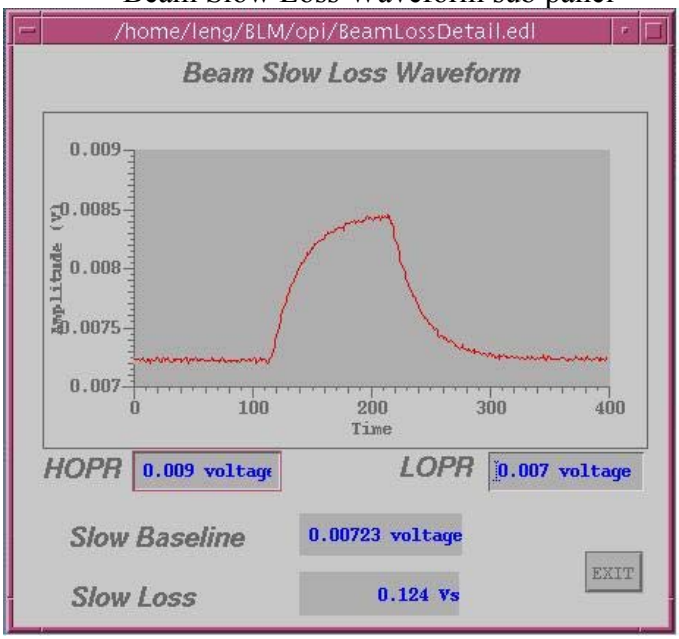
V124S Configuration

Channel1	Call sub panel to configure channel 1 of V124S module
Channel2	Call sub panel to configure channel 2 of V124S module



Beam Fast Loss Waveform sub panel

Beam Slow Loss Waveform sub panel



The BCM Labview software was enhanced to replace Portable Channel Access Server with iocCore software. A new process variable was added which represents the difference of the integrated current in the two current transformers. This measurement reflects beam loss between the current transformers, addressing a request from the Accelerator Readiness Review.

WBS 1.9.5.4 - Vacuum

Effort is under way to use EPICS RDB tools to create EPICS databases from spreadsheet descriptions of the process variables. The same technique may prove useful for generating HPRF EPICS databases.

WBS 1.9.5.6 – RF

Work continues to port the Bittware DSP "Host Interface Library" to the MVME2100 processor board. EPICS device support is still needed. The fundamental design of the LLRF system and controls interface got its first test when the LLRF DSP was used to drive one of the SNS cavities. For future tests, EPICS screens will be used to control and monitor the DSP-based feedback loops.

Work has begun on EDM "engineering screens" for HPRF. A ControlLogix PLC has been ordered. It will act as an EPICS interface to the PLC-5 based HPRF system.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
4362.4	4233.6	4254.0	(128.80)	-3.0%	(20.4)	-0.5%

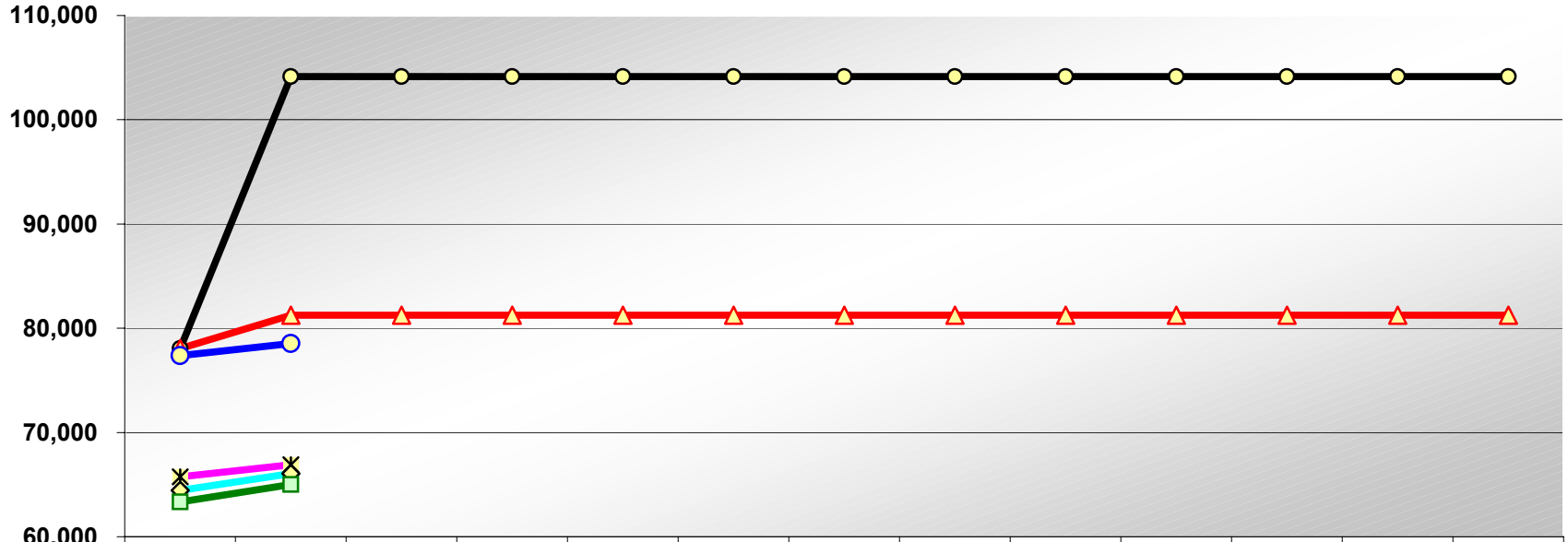
Variance Statement: Cum variances are within thresholds. No analysis required. Current period SV of -$112.3K (-44.8%) is driven by 1.9.5.3 Diagnostics; SV -$87.2K. Current period CV of $70K (50.5%) is driven by 1.9.5.1 Ring ICS Integration.

Project Impact: None.

Corrective Action: None.

IV. Earned Value Reports and Charts

1.5 & 1.1.3 Performance Measurement Chart



	Prior Yrs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Cum Planned BA	78,046	104,149	104,149	104,149	104,149	104,149	104,149	104,149	104,149	104,149	104,149	104,149	104,149
Cum Authorized BA	78,046	81,246	81,246	81,246	81,246	81,246	81,246	81,246	81,246	81,246	81,246	81,246	81,246
Cum Actual BA	77,363	78,526											
Cum BCWS	65,746	66,896											
Cum BCWP	64,446	66,066											
Cum ACWP	63,332	65,009											

Months

U.S. DEPARTMENT OF ENERGY
COST PERFORMANCE REPORT - WORK BREAKDOWN STRUCTURE (FORMAT 1)

PROJECT TITLE: SPALLATION NEUTRON SOURCE	**REPORTING PERIOD:** 1-Oct-02 thru 31-Oct-02	**PROJECT NUMBER:** 99-E-334
		START DATE: October 1998
PARTICIPANT NAME AND ADDRESS: Brookhaven National Laboratory Brookhaven, NY	**BCWS PLAN DATE:** October 1999	**COMPLETION DATE:** November 2006

WORK BREAKDOWN STRUCTURE	CURRENT PERIOD					CUMULATIVE TO DATE					AT COMPLETION		
	Budgeted Cost		Actual Cost of Work Performed	Variance		Budgeted Cost		Actual Cost of Work Performed	Variance				
	Work Scheduled	Work Performed		Schedule	Cost	Work Scheduled	Work Performed		Schedule	Cost	Budgeted	Revised Estimate	Variance
1.1.3 Rings System Development	0.0	0.0	0.00	0.0	0.0	5,115.0	5,115.0	5,112.9	0.0	2.1	5,115	5,115	0.0
1.5 Ring & Transfer Line System	1,150.6	1,619.1	1,677.1	468.5	(58.0)	61,781.5	60,950.5	59,895.7	(831.0)	1,054.9	112,076	112,076	0.0
1.5.1 HEBT (High Energy Beam Transport) Systems	149.9	339.7	106.4	189.8	233.3	5,715.9	6,241.5	4,806.0	525.6	1,435.4	9,841	9,841	0.0
1.5.2 Injection Systems	56.0	160.6	457.2	104.6	(296.6)	4,772.1	5,125.6	4,917.6	353.6	208.0	9,301	9,301	0.0
1.5.3 Magnet Systems	150.6	245.13	258.3	94.5	(13.2)	11,126.4	10,979.5	11,287.5	(146.9)	(308.0)	16,935	16,935	0.0
1.5.4 Power Supply System	13.3	11.7	14.6	(1.6)	(2.9)	1,227.8	966.7	1,114.8	(261.1)	(148.1)	3,746	3,746	0.0
1.5.5 Vacuum System	127.4	106.6	168.3	(20.9)	(61.7)	5,165.3	5,070.1	5,169.8	(95.2)	(99.7)	9,727	9,727	0.0
1.5.6 RF System	161.8	88.9	208.4	(72.9)	(119.5)	7,417.3	7,070.0	7,128.8	(347.3)	(58.8)	11,875	11,875	0.0
1.5.7 Ring Systems Diagnostic Instrumentation	142.8	328.8	177.5	186.0	151.3	7,236.6	6,887.2	6,854.1	(349.4)	33.0	13,584	13,584	0.0
1.5.8 Collimation and Shielding	27.6	24.3	15.2	(3.3)	9.0	1,817.9	1,635.5	1,649.6	(182.4)	(14.1)	3,380	3,380	0.0
1.5.9 Extraction System	55.5	48.9	41.8	(6.6)	7.1	1,742.8	1,671.1	1,754.6	(71.6)	(83.4)	6,165	6,165	0.0
1.5.10 RTBT (Ring to Target Beam Transport) System	68.9	67.9	41.4	(1.1)	26.5	3,109.3	2,853.1	3,083.1	(256.2)	(229.9)	7,235	7,235	0.0
1.5.11 Cable	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.0	0.0	0.7	0.7	0.0
1.5.12 Technical Support	196.7	196.7	188.0	0.0	8.8	12,449.5	12,449.5	12,129.1	0.0	320.4	20,287	20,287	0.0
WBS SUBTOTAL	1,150.6	1,619.1	1,677.1	468.5	(58.0)	66,896.5	66,065.5	65,008.6	(831.0)	1,056.9	117,191		
UNDISTRIBUTED BUDGET													
SUBTOTAL	1,150.6		1,677.1			66,896.5		65,008.6			117,191		
MANAGEMENT RESERVE													
TOTAL	1,150.6		1,677.1			66,896.5		65,008.6			117,191		

RECONCILIATION TO CONTRACT BUDGET BASE

DOLLARS EXPRESSED IN: THOUSANDS	SIGNATURE OF PARTICIPANT'S PROJECT DIRECTOR: Jie Wei	DATE: November 19, 2002